In the preface to his "Easy Mathematics," 1906, Sir Oliver Lodge stated that "the mathematical ignorance of the average educated person has always been complete and shameless." One cause of this ignorance has been the lack of popular and reliable books dealing with serious mathematical subjects. By the publication of the present volume Professor Keyser has rendered a very notable service towards the supply of such popular books. He has introduced into the book at various places somewhat serious doses of mathematics but these places are probably sufficiently separated by non-mathematical material to hold the reader who would not be interested in a book restricted to real mathematics.

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SPECIAL ARTICLES

THE "WINTER CYCLE" IN THE FOWL

THE idea of the superimposition of a Mendelian factor or factors determining the egg production of the "winter cycle" upon the factors determining the egg production of the normal or "reproductive cycle" has become widely familiar as an explanation of the phenomenon of the inheritance of fecundity in the domestic fowl.

In recent years there has been much skepticism among geneticists concerning the validity of this hypothesis. Crucial evidence for or against it is difficult to obtain.

Some light may be thrown upon the problem by the determination of the correlations between the egg records of the various "cycles" in the first and second laying year. If the birds of a flock differ fundamentally among themselves by reason of the presence in or absence from the zygotes from which they developed of Mendelian genes or factors determining their winter egg production, it would be logical to expect that the highest inter-annual correlation[1] would be that of the winter period. This must be considered true under the theory stated unless the further assumption be made that genes of factors which determine egg production during the "winter cycle" of the first laying year have no influence in determining production during the "winter cycle" of the second laying year.

We have, therefore, determined all possible correlations between the total egg records of the "cycles" of the first and of the second year for a series of 443 White Leghorn birds, for which complete records for the first two laying years are available.[2]

The correlations appear in the accompanying table. These show that for all four periods considered there is a higher correlation between the records of homologous periods than be-

[1] Harris, J. Arthur: "The Value of Inter-annual Correlations," *Amer. Nat.*, Vol. 49, 707-712, 1915.

[2] An exhaustive series of correlations for the egg records of the individual months of the first and second year was determined some months ago and is now in press in *Genetics*. The correlations for the total productions of the "cycles" have been only recently determined, because of the difficulty of dealing with the moments of such large numbers without grouping.

		Bird's First Year				
		Winter[3]	Spring[3]	Summer[3]	Autumn[3]	Annual
Bird's Second Year	Winter	+.3225 ± .0301 10.71[4]	+.0680 ± .0335 2.02	+.1269 ± .0331 3.83	+.3142 ± .0303 10.36	+.2955 ± .0307 9.62
	Spring	+.1177 ± .0332 3.54	+.3293 ± .0300 10.97	+.2060 ± .0322 6.39	+.1874 ± .0325 5.76	+.2782 ± .0310 8.97
	Summer	+.0976 ± .0333 2.93	+.3047 ± .0305 9.99	+.4272 ± .0275 15.53	+.2904 ± .0308 9.42	+.4026 ± .0282 14.27
	Autumn	+.2535 ± .0315 8.04	+.0369 ± .0336 1.09	+.2679 ± .0312 8.58	+.5545 ± .0233 23.79	+.4115 ± .0279 14.74
	Annual	+.3255 ± .0301 10.81	+.2352 ± .0318 7.39	+.3641 ± .0292 12.46	+.5127 ± .0248 20.67	+.5134 ± .0248 20.70

[3] The conventional limits of these "cycles" are as follows: Winter, November to February; spring, March to May; summer, June to August; autumn, September to October.

[4] Ratio of correlation coefficient to its probable error.

tween those which are not homologous. They show, furthermore, that the correlation between the winter periods of the first and second year is the lowest of any of the four correlations between the productions of homologous periods. The difference between the winter-winter correlation and the spring-spring correlation is not large, but the differences between the winter-winter correlation and the summer-summer and the autumn-autumn coefficients are more substantial, the two latter being 2.57 and 6.10 times as large as their probable error.

In so far as this type of evidence is pertinent to the problem, it indicates that in the White Leghorn at least there is no evidence of special factors which distinguish the "winter cycle" from any other period of the year.

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THE EFFECT OF X RAYS ON CHEMICAL REACTIONS

WHILE investigating with Dr. E. Dershem absorption coefficients for X rays, a brass cell with aluminum windows containing cyclohexanol was subjected to the X rays and afterwards opened. The contents showed very striking and unexpected consequences due to this exposure. The colorless hexanol had turned to greenish-blue, and later analysis showed that about 0.1 of a gram of copper had gone into solution.

The intensity of the X rays was so small, coming as a nearly monochromatic beam from a crystal grating, that the amount of chemical action produced was most surprising. The geometry of our apparatus and the power used by the X ray bulb enabled us to calculate the maximum energy which could be involved. Assuming the target and the crystal grating to be 100 per cent. efficient, and taking one hour as the maximum time exposure, the energy received by the cell could not be greater than 3×10^6 ergs, or less than 0.1 of a calorie.

Using the quantum theory, we may calculate from the wave length, approximately 0.2 Å, the number of quanta entering the cell. The energy per quantum is 1×10^{-7} ergs. Therefore the number of quanta received could not be greater than 3×10^{13}. Since about 0.1 gram of copper went into solution each quantum must have caused at least 3.3×10^7 atoms of copper to react.

The small amount of energy involved, and the small number of quanta relative to the number of atoms reacting, indicate that the reaction is an exothermal one. The quantum voltage producing the X rays was approximately 10^5 volts. Since each quantum caused 3.3×10^7 atoms to react, not more than 3×10^{-3} volts could be expended on each atom if the reaction were endothermal. This value is only one five-hundredth of the smallest known resonance potential, that for cæsium as determined by Foote, Rognley and Mohler,[2] being 1.48 volts.

We therefore must conclude that the X rays produced some sort of trigger action of the type studied by Bodenstein and Taylor[3] and by Jorissen and Ringer[4] in their work on the formation of hydrochloric acid from hydrogen and chlorine by means of alpha particles. An excellent discussion of this work will be found in a monograph by Lind.[5]

Mesitylene showed a behavior similar to that of cyclohexanol, but in this case the color was a yellowish green. This difference in color may be due to concentration effects.

On account of the large effect produced by relatively small amounts of energy, it seems that the use of X rays may acquire great importance in the production of organic compounds, especially if substances are produced in this manner which can not be obtained by other means.

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[2] Foote, Rognley and Mohler, *Phys. Rev.*, 61 (1919).

[3] (M. Bodenstein) and H. S. Taylor, *J. Am. Chem. Soc.*, 37: 24 (1915).

[4] Jorissen and Ringer, Ber., 39: 2095 (1906).

[5] S. C. Lind, *The Chemical Effects of Alpha Particles and Electrons*, Chemical Catalog Co., New York (1921).